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Transoral laser microsurgery using high-flow nasal cannula oxygenation: Our experience of 21 cases

Susanne Flach^{1,2}, Azza Elhoweris¹, Samit Majumdar¹, Simon Crawley³, Jaiganesh Manickavasagam¹

¹Department of Otorhinolaryngology and Head & Neck Surgery and Tayside Medical Sciences Centre, Ninewells Hospital, Dundee, U.K.

²Department of Otolaryngology, Hospital of the Ludwig-Maximilians-University, Munich, Germany

³Department of Anaesthesia, Ninewells Hospital, Dundee, U.K.

Contact details:

Susanne Flach

Department of Otolaryngology

Hospital of the Ludwig-Maximilians-University

Marchioninistrasse 15

81377 Munich

Germany

E-mail: susanne.flach@googlemail.com

Introduction

Transoral laser microsurgery (TLM) using carbon dioxide lasers (CO₂) has become a widely used technique for treatment of a variety of oropharyngeal and laryngeal conditions.¹ The traditional method for providing oxygenation during TLM involves controlled mechanical ventilation via a laser safe endotracheal tube (ETT). However, access and visualisation of the upper airway can be challenging.² Alternatively, methods of tubeless field anaesthesia include supraglottic, transglottic and transtracheal jet ventilation and low-flow oxygen delivery as part of a spontaneously ventilating technique.³ Although jet ventilation provides a tubeless surgical field and improved visibility, there is a risk of barotrauma from airway outflow obstruction,² potential desiccation and trauma of the supraglottis from ventilation pulses with subsequent mucosal oedema.⁴ As for spontaneous ventilation, it offers an optimal view for the surgeon, however, worrying features are inhalation risks of laser fumes and a moving surgical field.²

Humidified oxygenation via high-flow nasal cannulae (HFNC) has been increasingly adopted in adult patients in the emergency department for respiratory failure and in the critical care environment. Its introduction into anaesthetic practice and airway management has revolutionised practice. HFNC systems can deliver oxygen at a flow rate of up to 70 l/min and a fraction of inspired oxygen reaching 100%. Heated and humidified oxygen delivery via HFNC improves patient tolerance compared to existing approaches such as biphasic positive airway pressure ventilation therapy, maintains mucociliary clearance and decreases ventilation-perfusion mismatching by

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recruiting atelectatic alveoli. HFNC have been suggested to be useful for airway management during respiratory or anaesthetic procedures due to improved oxygenation from positive airway pressure generation and the ability for uninterrupted oxygenation.⁵⁻⁷ Apnoeic oxygenation and ventilation, described as Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE), has been utilised for patients undergoing general anaesthesia for hypopharyngeal and laryngotracheal surgery.⁸

Airway fires are a feared complication. All three components of a “fire triad” have to be present for an airway fire to occur: fuels including ETTs and sponges in the airway, oxidisers such as oxygen or anaesthetic gases, and ignition sources, e.g. lasers. All of these components could come into close proximity during TLM.⁹ Therefore uncertainty exists about fire risks of TLM in the presence of oxygen-rich environments such as during HFNC oxygenation. There was an initial keenness to explore the use of HFNC within this setting with some experts proposing its safety due to absence of a fuel source in the form of ETTs. To our knowledge there have been no reports describing complications in patients who underwent TLM using HFNC as part of their airway management.

Here, we describe our initial experience with CO₂ laser excision for treatment of a variety of oropharyngeal and laryngeal conditions in adult patients using the HFNC. It must be noted, this is not the current practice of our institution. Much like many other centres who may have introduced this practice, many have more recently limited its utility to purely diagnostic upper airway procedures whilst awaiting more evidence surrounding its use in airway laser surgery.

Materials and Methods

We retrospectively reviewed medical records of 21 cases, who underwent elective transoral CO₂ laser-aided treatment of oropharyngeal and laryngeal conditions with heated humidified oxygen delivery via HFNC at the Department of Otolaryngology and Head & Neck Surgery, Ninewells Hospital, Dundee, U.K., between January 2015 and February 2018. We recorded the time of HFNC use from the operation notes. Our main outcome was safety. Secondary outcome measures included feasibility, complications, HFNC usage time and surgical access.

Ethical considerations

This study was approved by the NHS Tayside Caldicott Guardian (ref. IGTCAL4718).

Technique

This was a retrospective case note review and as such there was no standardised anaesthetic protocol. All patients had been anaesthetised by consultant anaesthetists who have regular exposure to laryngotracheal surgery, using standards of monitoring as dictated by the Association of Anaesthetists of Great Britain and Ireland.¹⁰ Pre-oxygenation was achieved with use of high flow nasal oxygen at flow rates of up to 50 l/min. All cases were anaesthetised using a total intravenous anaesthetic technique using target controlled infusions of propofol and remifentanyl. Bispectral index monitoring was used in addition to other monitors to guide anaesthetic management. Following induction, the airway was maintained with maximal airway manoeuvres to ensure airway patency. Laryngoscopy was performed and additional airway anaesthesia was achieved by application of 4 %

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lidocaine to the supraglottis, glottis and subglottis, if required, prior to suspension laryngoscopy. Oxygen flow rate was increased to 70 l/min. During the procedure only wet patties were used and no drapes or sponges were left within the oral cavity. Cases undergoing balloon dilatation of subglottic stenosis were anaesthetised using a spontaneous ventilation technique which has since been described by Booth et al.¹¹ Other procedures, such as cordotomy, utilised an apnoeic technique throughout with cessation or reduction of oxygen flow during laser use. After surgery, in both patient types, a supraglottic airway device was inserted prior to cessation of anaesthetic infusion to allow emergence from anaesthesia.

Results

Out of the 21 TLM cases presented here, where HFNC oxygenation was used for airway management, 48% had treatment for subglottic stenosis, 29% underwent cordectomy, 14% had excision of a laryngeal papilloma and 9% had a vocal cord lesion excised. A summary of the results is shown in Table 1. HFNC usage time ranged from 15 min to 95 min. For 20 cases no intra- or immediate post-operative complications were recorded. Adequate surgical access and completion of the planned procedure was achieved in all of the 21 cases. Importantly, no airway fires or similar adverse events such as flaring were mentioned. One patient (case 6) had a brief episode of low oxygen saturations during balloon dilatation for subglottic stenosis. The balloon was deflated at oxygen saturations of 90% and saturations fell to 84% secondary to transient upper airway obstruction. The patient recovered rapidly and had further CO₂ laser treatment to a tracheal stenosis.

Discussion

We recognise the small number of cases in this analysis but hope it can add to the evidence to the use of TLM. In our experience, HFNC provided a safe and efficient oxygenation system during transoral endoscopic surgery using CO₂ lasers. Apart from one transient episode of desaturation there were no safety concerns or complications related to HFNC oxygenation. Adequate surgical access was achieved for all cases with a median HFNC usage time of 45 min. In this study, half of the patients who received high flow nasal oxygenation had treatment for subglottic stenosis. Securing a safe airway for both intra-operative oxygenation and for the surgical procedure is one of the most important aspects in the surgical management of this condition. The main advantage of HFNC is that it allows safe and effective oxygenation of the patient in addition to good surgical access and avoidance of potentially serious risks associated with other methods of airway management.³ One case study by Tam *et al.*¹² described the use of Optiflow™ HFNC oxygenation for CO₂ laser excision of supraglottic-pharyngeal stenosis. The group used a combination of pre-oxygenation and intra-operative apnoeic oxygenation for successful treatment of the stenosis without any complications. Even though a CO₂ laser was used in an oxygen-rich environment an airway fire was unlikely to happen unless a fuel source such as an inhaled gas, airway-sponges, or an ETT were introduced, and so completing the components of the fire triad. There is one case report by Onwochei *et al.*¹³ describing a brief ignition within the oral cavity during the use of monopolar diathermy and Optiflow™ THRIVE in a sedated patient having a hard palate biopsy. Contrary to the report by Tam *et al.*¹², the fire triad was completed in this case with HFNC oxygenation, the needle diathermy shaft insulation providing fuel, and ignition caused by an arc discharge between the diathermy needle tip and titanium implant screws in the patient's palate. A Pubmed search

conducted by us did not identify any further published reports about airway fires resulting from use of HFNC and TLM.

HFNC oxygenation can allow for safe and effective tubeless field anaesthesia and the risk of airway fires is low if the correct safety precautions are implemented. These cases were undertaken with a high level of vigilance in the early phases of introducing this technique to our practice as this was a new technique to us. Although our use of TLM and HFNC is currently on hold in concordance with manufacturer guidance, we feel that this cohort may add to the evidence base. Our experience, albeit in small numbers is positive if done by senior and experienced clinicians who can maintain that high standard of care and vigilance. Other centres who may have employed these techniques in the past may have similar experience. We also strongly believe that any potential reintroduction of this practice in future should be based on a larger evidence base and cases be carried out by experienced consultant surgeons and anaesthetists who are familiar with both airway laser surgery and tubeless field anaesthesia.

Keypoints

- Optimal access and visualisation is crucial during TLM, however, airway management can be challenging.
- Oxygenation via HFNC provides a safe and effective way for airway management during tubeless field anaesthesia in TLM.
- HFNC oxygenation during TLM is well tolerated and avoids risks associated with other methods of tubeless field anaesthesia.
- HFNC oxygenation during TLM should only be used in appropriate clinical situations for selected cases.
- HFNC oxygenation during TLM should only be used with a consultant level operator and consultant anaesthetist involvement, necessary safety precautions in place, while keeping the components of the fire triad in mind.

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Table 1. Summary of TLM cases with HFNC airway management. M = Male, F = Female. Patients who had TLM twice are indicated with a superscript character (*, § or &).

Case	Gender	Age	Type of operation	HNFC time	Complications
1	M	48	Laryngeal papilloma excision	50min	None recorded
2	M	63	Vocal cord lesion excision	45min	None recorded
3	F	65	Dilatation of subglottic stenosis	60min	None recorded
4*	F	34	Dilatation of subglottic stenosis	60min	None recorded
5	M	58	Corpectomy	45min	None recorded
6	F	50	Dilatation of subglottic stenosis	15min	Transient low sats during balloon dilatation
7	F	60	Corpectomy	30min	None recorded
8	F	78	Corpectomy	45min	None recorded
9	F	40	Dilatation of subglottic stenosis	75min	None recorded
10 [§]	M	65	Corpectomy	45min	None recorded
11	F	38	Dilatation of subglottic stenosis	45min	None recorded
12*	F	35	Dilatation of subglottic stenosis	45min	None recorded
13 ^{&}	M	24	Dilatation of subglottic stenosis	45min	None recorded
14 ^{&}	M	24	Dilatation of subglottic stenosis	30min	None recorded
15	F	28	Dilatation of subglottic stenosis	95min	None recorded
16	F	63	Vocal cord lesion excision	45min	None recorded
17	F	46	Corpectomy	45min	None recorded
18	M	52	Laryngeal papilloma excision	36min	None recorded
19	M	27	Dilatation of subglottic stenosis	75min	None recorded

20 ^{\$}	M	66	Corpectomy	25min	None recorded
21	F	60	Laryngeal papilloma excision	60min	None recorded